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## DESCRIPTION

### INFORMATION RECORDING/PLAYBACK SYSTEM

#### Technical Field

The present invention relates to an information recording/playback system which prevents illegal copying of recording media, and to an information recording apparatus, an information playback apparatus, an authentication data recording apparatus, an authentication processing apparatus, an information recording/playback method, an information recording method, an information playback method, an authentication data recording method, an information-recording-medium authentication method, and an information recording medium.

#### Background Art

In recent years, apparatuses for transmitting and recording digital data such as music information and video information have come to be widely used in households. Since data can be recorded and read with high quality in these apparatuses, it is possible to construct a recording system in which there is no deterioration in quality even if copying is performed repeatedly. Such a recording system must include a copyright protection function to prevent copyrighted data from being illegally copied.

As such a system for the protection of copyright, for example, there is a content

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In this system, all copyrighted data on a disk is encrypted and only an apparatus which has received a license is given an encryption key for obtaining meaningful data by decrypting encrypted data. The licensed apparatus is designed to conform with operation specifications so that illegal copying may not be performed.

## Disclosure of the Invention

Accordingly, an object of the present invention is to provide an information recording/playback system constituting an illegal-copying prevention system which is also effective for RAM media, and to provide an information recording apparatus, an information playback apparatus, an authentication data recording apparatus, an authentication processing apparatus, an information recording/playback method, an information recording method, an information playback method, an authentication data recording method, an information-recording-medium authentication method, and an information recording medium.

The present invention is an information recording/playback system for recording and playing back information and is characterized by comprising: an authentication data recording control part which provides control of detecting random pattern information based on random physical phenomena from a random-pattern-information recording part used for recording such random-physical-phenomena-based random pattern information on an information recording medium; generating medium identification information from the random pattern information; and recording the medium identification information as authentication data in the authentication data recording part on the information recording medium; an authentication processing part which detects the random pattern information from the random-pattern-information recording part, generates medium-identification-information verification data from the random pattern information; reads authentication data from the authentication data recording part on the information recording medium; and performs authentication processing for the information recording medium based on medium-identification-information verification data generated from the random pattern information and based on the authentication data; and an information recording/playback control part which provides control of recording information on an information recording medium and playing back information from an information recording medium based on an authentication result from the authentication processing part.

Furthermore, the present invention is an information recording apparatus for

recording information on an information recording medium including: a random-pattern-information recording part which records random pattern information based on random physical phenomena; and an authentication data recording part which stores, as authentication data; medium identification information created according to random pattern information detected from the random-pattern-information recording part, and is characterized by comprising: a random-pattern-information detection part which detects random pattern information from the random-pattern-information recording part on the information recording medium; a verification data creation part which creates medium-identification-information verification data from random pattern information detected by the random-pattern-information detection part; an authentication processing part which reads authentication data from the authentication data recording part on the information recording medium; performs authentication processing for an information recording medium based on medium-identification-information verification data created by the verification data creation part and based on the authentication data; and controls whether to enable writing information onto an information recording medium based on an authentication result; and a recording control part which provides control of recording information onto an information recording medium.

Furthermore, the present invention is an information playback apparatus for playing back information from an information recording medium including: a random-pattern-information recording part which records random pattern information

based on random physical phenomena; and an authentication data recording part which stores; as authentication data; medium identification information created according to random pattern information detected from the random-pattern-information recording part; and is characterized by comprising: a random-pattern-information detection part which detects random pattern information from the random-pattern-information recording part on the information recording medium; a verification data creation part which creates medium-identification-information verification data from random pattern information detected by the random-pattern-information detection part; an authentication processing part which reads authentication data from the authentication data recording part on the information recording medium, and performs authentication processing for an information recording medium based on medium-identification-information verification data created by the verification data creation part and based on the authentication data; and a playback control part which provides control of reading information from an information recording medium.

In an authentication data recording apparatus which records authentication information on an information recording medium, the present invention is characterized by comprising: a random-pattern-information detection part which detects random pattern information from a random-pattern-information recording part on an information recording medium used for recording random pattern information based on random physical phenomena; a medium identification information creation part which creates medium identification information from the random pattern

information detected by the random-pattern-information detection part; and an authentication data recording control part which provides control of recording, as authentication data, medium identification information created by the medium identification information creation part by using an authentication data recording part on the information recording medium.

In an authentication processing apparatus which performs authentication processing for an information recording medium, the present invention is characterized by comprising: a random-pattern-information detection part which detects random pattern information from a random-pattern-information recording part on the information recording medium; a verification data creation part which creates medium-identification-information verification data from random pattern information detected by the random-pattern-information detection part; and an authentication processing part which plays backs authentication data from a authentication data recording part on an information recording medium and performs authentication processing for an information recording medium based on medium-identification-information verification data created by the verification data creation part and based on the authentication data.

Further, the present invention is an information recording/playback method for recording and playing back information, and is characterized by comprising: an authentication data recording control process which detects random pattern information based on random physical phenomena from a random-pattern-information

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recording part used for recording random pattern information based on random physical phenomena on an information recording medium, creates medium identification information from the random pattern information, and controls recording; as authentication data; the medium identification information in an authentication data recording part on the information recording medium; an authentication process which detects the random pattern information from the random-pattern-information recording part; creates medium-identification-information verification data from the random pattern information; reads authentication data from an authentication data recording part on the information recording medium; and performs authentication processing for the information recording medium based on medium-identification-information verification data created from the random pattern information and based on the authentication data; and an information recording/playback control process which provides control of recording information on an information recording medium and playing back information from an information recording medium based on an authentication result from the authentication process.

Furthermore, the present invention is an information recording method for recording information on an information recording medium including: a random-pattern-information recording part which records random pattern information based on random physical phenomena; and an authentication data recording part which stores, as authentication data, medium identification information created according to

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random pattern information detected from the random-pattern-information recording part; and is characterized by comprising: a random-pattern-information detection process which detects random pattern information from a random-pattern-information recording part on an information recording medium; a verification data creation process which creates medium-identification-information verification data from random pattern information detected by the random-pattern-information detection process; an authentication process which reads authentication data from the authentication data recording part on an information recording medium; performs authentication processing for an information recording medium based on medium-identification-information verification data created by the verification data creation process and based on the authentication data; and controls whether to enable writing information onto an information recording medium based on an authentication result; and a recording control process which provides control of recording information onto an information recording medium.

Furthermore, the present invention is an information playback method for playing back information from an information recording medium including: a random-pattern-information recording part which records random pattern information based on random physical phenomena; and an authentication data recording part which stores; as authentication data, medium identification information created according to random pattern information detected from the random-pattern-information recording part; and is characterized by comprising: a random-pattern-information detection



process which detects random pattern information from a random-pattern-information recording part on an information recording medium; a verification data creation process which creates medium-identification-information verification data from random pattern information detected by the random-pattern-information detection process; an authentication process which reads authentication data from an authentication data recording part on the information recording medium; and performs authentication processing for an information recording medium based on medium-identification-information verification data created by the verification data creation process and based on the authentication data; and a playback control process which controls reading information from an information recording medium.

In an authentication data recording method which records authentication information on an information recording medium, the present invention is characterized by comprising: a random-pattern-information detection process which detects random pattern information from a random-pattern-information recording part on an information recording medium used for recording random pattern information based on random physical phenomena; a medium identification information creation process which creates medium identification information from the random pattern information detected by the random-pattern-information detection part; and an authentication data recording control process which provides control of recording, as authentication data; medium identification information created by the medium identification information creation process by using an authentication data recording

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part on the information recording medium.

In an authentication processing method which performs authentication processing for an information recording medium, the present invention is characterized by comprising: a random-pattern-information detection process which detects random pattern information from a random-pattern-information recording part on an information recording medium; a verification data creation process which creates medium-identification-information verification data from random pattern information detected by the random-pattern-information detection process; and an authentication process which plays back authentication data from an authentication data recording part on an information recording medium, and performs authentication processing for an information recording medium based on medium-identification-information verification data created by the verification data creation process and based on the authentication data.

With respect to information recording medium for recording information, the present invention is characterized by comprising: a random-pattern-information recording part which records random pattern information based on random physical phenomena; an authentication data recording part which stores, as authentication data, medium identification information created according to random pattern information detected from the random-pattern-information recording part; and an information recording part for recording information.

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## Brief Description of the Drawings

FIG. 1 is a view illustrating an optical disk to which the present invention is applied;

FIG. 2 is a block diagram showing the construction of an authentication data recording apparatus for recording authentication data on the optical disk;

FIG. 3 is a flowchart showing specific processing contents of an authentication data creation part in the authentication data recording apparatus;

FIG. 4 is a block diagram showing the construction of an optical disk recording/playback apparatus which uses the optical disk;

FIG. 5 is a flowchart showing specific processing contents of an authentication processing part in the optical disk recording/playback apparatus;

FIG. 6 is a view showing a revocation list used for authentication processing by the authentication processing part;

FIG. 7 is a view showing a public key list used for authentication processing by the authentication processing part;

FIG. 8 is a block diagram showing the construction of an encryption part of a recording/playback circuit of the optical disk recording/playback apparatus;

FIG. 9 is a view schematically showing the structure of data recorded on an optical disk by the optical disk recording/playback apparatus;

FIG. 10 is a block diagram showing the construction of a decryption part of the recording/playback circuit in the optical disk recording/playback apparatus;

FIG. 11 is a flowchart showing the operation of a recording mode of the optical disk recording/playback apparatus;

FIG. 12 is a flowchart showing the operation of a playback mode of the optical disk recording/playback apparatus;

FIG. 13 is a block diagram showing another example of the construction of an encryption part of the recording/playback circuit in the optical disk recording/playback apparatus;

FIG. 14 is a block diagram showing another example of the construction of a decryption part of the recording/playback circuit in the optical disk recording/playback apparatus; and

FIG. 15 is a view illustrating a card-shaped information recording medium to which the present invention is applied.

#### Best Mode For Carrying Out the Invention

The best mode for carrying out the present invention is described in detail below with reference to the drawings.

The present invention is applied to a recording/playback system employing, for example, an optical disk 1 having a construction such as that shown in FIG. 1.

The optical disk 1 shown in FIG. 1 is a disk medium into which and from which information can be recorded/played back, and has a user data recording part 3, a random-pattern-information recording part 4, and an authentication data recording part

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5, which are three information recording areas formed annularly around a center hole 2 at the center. The user data recording part 3, the random-pattern-information recording part 4, and the authentication data recording part 5 are placed, for example, so as to be separated in a two-dimensional manner or separated in a three-dimensional manner so that these parts can be accessed independently of each other in order to read information.

In this optical disk 1, the information recording area is separated in a two-dimensional manner in the radial direction of the disk, thereby forming the user data recording part 3, the random-pattern-information recording part 4, and the authentication data recording part 5.

In this optical disk 1, the user data recording part 3 formed in the periphery thereof is a data area in which user data is recorded or played back. Namely, this area records contents such as video, music, and the like.

Also, the random-pattern-information recording part 4 which is formed in a central part thereof is a read-only area in which random pattern information based on random physical phenomena is recorded.

This random-pattern-information recording part 4 is formed by randomly scattering, for example, fine magnetized fibers in the area of this random-pattern-information recording part 4 and by fixing them when the medium is manufactured. The random-pattern-information recording part 4 formed in this manner is one in which the random pattern information in the fine magnetized fibers

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The random-pattern-information recording part 4 may be such that bits are randomly formed and the jitter thereof can be detected as random pattern information.

In the optical disk 1 having such a construction, authentication data is recorded in the authentication data recording part 5 by an authentication data recording apparatus 10 constructed, for example, as shown in FIG. 2.

This authentication data recording apparatus 10 shown in FIG. 2 comprises a spindle motor 12 controlled by a servo circuit 11, a recording/playback head 13 which optically scans the information recording surface of the optical disk 1, a random-pattern-information detection part 14 for detecting random pattern information from the random-pattern-information recording part 4 of the optical disk 1, a medium-identification-information creation part 15 for creating medium identification information r, an authentication data creation part 16 for creating authentication data, and a control section 18 for controlling the servo circuit 11 and the authentication data

The spindle motor 12 drivingly rotates the optical disk 1, for example, at a constant linear velocity under the control of the servo circuit 11.

The recording/playback head 13, which comprises an optical head for optically scanning the authentication data recording part 5 of the optical disk 1 which is drivingly rotated by the spindle motor 12, records and plays back authentication data via the authentication data recording part 5.

The random-pattern-information detection part 14 comprises a magnetic head for scanning the random-pattern-information recording part 4 of the optical disk 1 which is drivingly rotated by the spindle motor 12, and detects in an analog manner the random pattern information from the random-pattern-information recording part 4. This random-pattern-information detection part 14 supplies the random pattern information detected from the random-pattern-information recording part 4 to the medium-identification-information creation part 15.

The medium-identification-information creation part 15 converts the random pattern information detected in an analog manner by the random-pattern-information detection part 14 into digital random pattern information, and supplies this information as medium identification information r to the authentication data creation part 16.

The authentication data creation part 16 affixes a digital signature for each manufacturer with respect to the medium identification information  $r$ , to the medium

identification information  $r$  supplied from the medium identification information creation part 15 in order to use it as authentication data.

Here, in creating authentication data to which a digital signature for each manufacturer is affixed by the authentication data creation part 16, the manufacturer for the recording medium uses a trusted center (TC), and registers its own public key required for the verification of the digital signature in the TC so as to request the TC to issue a certificate (Cert) in advance. The certificate (Cert) is data in which the TC has made a digital signature on the identification information ID of the manufacturer, the public key, etc.

The digital signature technology is a technology capable of certifying that a person who created particular data is a particular user. For example, an elliptic curve digital signature algorithm (EC-DSA) method used in the IEEE P1363 is well known.

In this authentication data recording apparatus 10, as the specific processing contents of the authentication data creation part 16 are shown in FIG. 3, additional information  $u$  such as the manufacturing date of the medium and the manufacturer ID is added to the medium identification information  $r$  supplied from the medium identification information creation part 15 in order to create data  $m$  (step S1). For this data  $m$ , digital signature data  $s$  is created by using a secret key for each manufacturer corresponding to the public key registered in the trusted center (step S2).

The additional information  $u$  is data which may be added to the medium identification information  $r$  as required.



Then, the authentication data creation part 16 combines the data m, the digital signature data s, the certificate (Cert) data, and the revocation list into authentication data w (step S3), and supplies this authentication data w to the recording/playback head 13 (step S4), whereby it is written in the authentication data recording part 5 of the optical disk 1.

Here, the additional information u, the secret key for each manufacturer, and the certificate (Cert) data are input, for example, from the input operation part 17 to the control part 18, whereby it is provided from the control part 18 to the authentication data creation part 16.

In this authentication data recording apparatus 10, the revocation list provided from the trusted center is input from the input operation part 17 to the control part 18, whereby the revocation list is provided from the control part 18 to the authentication data creation part 16 so that the revocation list can be recorded in the authentication data recording part 5 of the optical disk 1. In the authentication data recording part 5 of the optical disk 1, the latest revocation list provided from the trusted center is recorded.

Here, the revocation list is such that the trusted center has made a digital signature on the version number thereof which increases monotonously and the identification information ID of the manufacturer to which the secret key has been revealed and which is determined to have committed a fraud.

The manufacturer of the recording medium is able to manufacture the optical

The optical disk 1 having such a construction is capable of verifying the validity by authentication processing by the random pattern information detected from the random-pattern-information recording part 4 in which random pattern information from a random physical phenomenon is recorded, and the authentication data recorded in the authentication data recording part 16. The random pattern information recorded in the random-pattern-information recording part 4 cannot be reproduced because it is from a random physical phenomenon.

The optical disk recording/playback apparatus 20 shown in FIG. 4 comprises a spindle motor 22 controlled by a servo circuit 21; a recording/playback head 23 which optically scans the information recording surface of the optical disk 1; a random-pattern-information detection part 24 for detecting random pattern information from the random-pattern-information recording part 4 of the optical disk 1; a medium-identification-information verification-data creation part 25 for creating medium-identification-information verification data  $r'$ ; an authentication processing

part 26; a recording/playback part 27; and a control part 19 for controlling the servo circuit 21 and the recording/playback part 27 on the basis of setting information input from an input operation part 28.

The spindle motor 22 drivingly rotates the optical disk 1, for example, at a constant linear velocity under the control of the servo circuit 21.

The recording/playback head 23 comprises an optical head for optically scanning the information recording surface of the authentication data recording part 5 of the optical disk 1 which is drivingly rotated by the spindle motor 22. The recording/playback head 23 plays back the authentication data recorded in the authentication data recording part 5, and records data on and plays back data from the user data recording part 3.

The random-pattern-information detection part 24 comprises a magnetic head for scanning the random-pattern-information recording part 4 of the optical disk 1 which is drivingly rotated by the spindle motor 22, and detects in an analog manner random pattern information from the random-pattern-information recording part 4. This random-pattern-information detection part 24 supplies the random pattern information detected from the random-pattern-information recording part 4 to the medium-identification-information verification-data creation part 25.

The medium-identification-information verification-data creation part 25 accomplishes a conversion from information detected by the random-pattern-information detection part 24 in an analog manner to digital random

pattern information and supplies this information as medium-identification-information verification data  $r'$  to the authentication processing part 26.

The authentication processing part 26 performs a process for authenticating that the optical disk 1 is manufactured by an authorized manufacturer. The recording/playback part 27 supplies this authentication processing part 26 with authentication data  $w^\wedge$  which is read by the recording/playback head 23 from the authentication data recording part 5 of the optical disk 1. The authentication processing part 26 performs an authentication process on the basis of the medium-identification-information verification data  $r'$  supplied from the medium-identification-information creation part 25 and the authentication data  $w^\wedge$ .

The specific processing contents of the authentication processing part 26 are shown in FIG. 5.

More specifically, when the medium-identification-information verification data  $r'$  and the authentication data  $w^\wedge$  are input (step S11), initially, the authentication processing part 26 verifies the validity of the revocation list which is entered in the authentication data  $w^\wedge$ , that is, the validity of the digital signature of the trusted center, by using the public key of the trusted center (step S12). The public key of the trusted center is common to the entire system, and is stored in a nonvolatile memory within the apparatus when the apparatus is manufactured.

As a result of the verification of the revocation list, when the revocation list is

Next, the certificate (Cert) data in the authentication data  $w^*$  is extracted (step S15). It is verified that the identification information ID of the manufacturer contained in the certificate (Cert) data is not in the revocation list stored in the nonvolatile memory (step S16). Furthermore, it is verified that the digital signature of the trusted center, contained in the certificate (Cert) data, is correct (step S17).

When this verification is passed, data  $m^{\wedge}$  and digital signature data  $s^{\wedge}$  are extracted from the authentication data  $w^{\wedge}$  (step S18). It is verified by using the public key of the manufacturer in the certificate (Cert) data that the digital signature data  $s^{\wedge}$  in the authentication data  $w^{\wedge}$  is a correct digital signature of the manufacturer with respect to the data  $m^{\wedge}$  (step S19).

When this verification is passed, the verification result J2 is assumed to be passed (step S20).

Next, medium identification information  $\hat{r}$  and additional information  $\hat{u}$  are extracted from the authentication data  $\hat{w}$  (step S21).

Then, the medium identification information  $\hat{r}$  extracted from the authentication data  $\hat{w}$  is compared with the medium-identification-information verification data  $r'$  created by the medium-identification-information creation part 25

in order to verify that the difference is within a predetermined error (step S22). This example uses an allowable error in consideration of a possible error due to noises because digital medium-identification-information verification data  $r'$  is generated from random pattern information detected as an analog signal. No allowable error needs to be used when random pattern information is digitally recorded and read.

When this verification is passed, the verification result J1 is assumed to be passed (step S23).

When both the verification result J1 and the verification result J2 are passed, this recording medium is determined to be an authorized one, and the medium identification information  $r^{\wedge}$  is supplied as authenticated medium identification information DiscID to the recording/playback part 27 (step S24).

Here, the nonvolatile memory may store a public key list such as that shown in FIG. 7.

In this case, the public key list stores the identification information ID of the manufacturer, the public key thereof, and a flag indicating whether or not the identification information ID is revoked. Furthermore, the public key list stores the version number of the latest version of the revocation lists which have been handled by the apparatus.

When this apparatus obtains a valid revocation list which is newer than any of those handled by the apparatus from the data  $w^{\wedge}$ , a revocation flag corresponding to the identification information ID given in that list is set to "YES", that is, is set to be

revoked.

If the identification information ID is not in the table by that time, the item thereof is newly created and the flag is set to "YES".

In contrast, for those in which the identification information ID is not contained in the latest revocation list, although it is in the table stored by the apparatus, all the flags are set to "NO", that is, are set not to be revoked. Then, the item of the latest version number is updated.

When the certificate (Cert) data extracted from the authentication data  $w^{\wedge}$  is to be verified, the identification information ID of the manufacturer is checked. If the item of the identification information ID is in the stored list, the public key is recorded, and the revocation flag is "NO", the verification of the certificate (Cert) data is not necessary, and the public key recorded in the table is used.

When the item of the identification information ID is in the list, the flag is "NO", and the public key is not recorded, the certificate (Cert) data is verified, and when it is correct, the public key is stored in the table.

When the item of the identification information ID is in the list and the flag is "YES", the result of the verification J2 is assumed to be invalidated.

When the item of the identification information ID is not in the list, the certificate (Cert) data is verified. When it is correct, an item corresponding to the identification information ID is newly created, and the public key is stored. At this time, the flag is set to "NO".

The Kem generation module 31 comprises a Km memory 31A having a master key Km stored therein, and a hash function circuit 31B to which the master key Km is supplied from the Km memory 31A and to which authenticated medium identification information DiscID is supplied from the authentication processing part



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The master key  $K_m$  is a secret key which is given when the license of copyright is received.

The hash function circuit 31B concatenates an  $n$ -bit master key  $K_m$  and an  $m$ -bit medium identification information  $\text{DiscID}$  in order to create  $(n + m)$ -bit concatenated data  $(\text{DiscID} \parallel K_m)$  in which, for example, the low-order bits are the master key  $K_m$  and the high-order bits are the medium identification information  $\text{DiscID}$ , and applies a hash function  $H$  to the created concatenated data  $(\text{DiscID} \parallel K_m)$ , as shown in the following equation (1):

$$K_{em} = H(\text{DiscID} \parallel K_m) \quad (1)$$

in order to create an effective master key  $K_{em}$ . Then, the hash function circuit 31B supplies the  $K_d$  encryption/decryption circuit 33 with the master key  $K_m$  and the effective master key  $K_{em}$  created from the authenticated medium identification information  $\text{DiscID}$ .

Here, " $\parallel$ " of  $A \parallel B$  means the concatenation of data  $A$  and data  $B$ . Also, the hash function is a function which outputs data of a fixed length, for example, 64 bits or 128 bits, with respect to input data of an arbitrary length, and is a function such that, when  $y (= \text{hash}(x))$  is given, determination of  $x$  is difficult and determination of the set of  $x_1$  and  $x_2$  in which  $\text{hash}(x_1) = \text{hash}(x_2)$  is also difficult. As representative

one-direction hash functions, MD5 (Message Digest) and SHA (Secure Hash Algorithm) are known. This one-direction hash function is described in detail in "Applied Cryptography (Second Edition), Wiley" written by Bruce Schneier.

Furthermore, the random number generation circuit 32 generates random numbers in which random numbers are used as a sector key  $K_{si}$  and a disk key  $K_d$ , supplies the sector key  $K_{si}$  to the  $K_s$  encryption circuit 34 and the content data encryption circuit 35, and supplies the disk key  $K_d$  to the  $K_d$  encryption/decryption circuit 33 and the  $K_s$  encryption circuit 34.

The  $K_d$  encryption/decryption circuit 33 encrypts, by the effective master key  $K_{em}$ , the disk key  $K_d$  supplied from the random number generation circuit 32 in order to create an encrypted disk key  $E_{Kd}$ . This encrypted disk key  $E_{Kd}$  created by the  $K_d$  encryption/decryption circuit 33 is recorded in the lead-in area of the optical disk 1 via the recording/playback head 23. Also, this  $K_d$  encryption/decryption circuit 33 decrypts the encrypted disk key  $E_{Kd}$  read from the lead-in area of the optical disk 1 via the recording/playback head 23 in order to create a disk key  $K_d$ . This disk key  $K_d$  created by the  $K_d$  encryption/decryption circuit 33 is supplied to the  $K_s$  encryption circuit 35.

Also, the  $K_s$  encryption circuit 34 encrypts, by the disk key  $K_d$ , the sector key  $K_{si}$  supplied from the random number generation circuit 32 in order to create an encrypted sector key  $E_{Ks}$ . This encrypted sector key  $E_{Ks}$  created by the  $K_s$  encryption circuit 34 is recorded in the data area of the optical disk 1 via the

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Furthermore, the content data encryption circuit 35 creates encrypted content data by encrypting, by the sector key K<sub>si</sub>, the user data supplied as content data from an external source.

Here, the data area of the optical disk 1 is formed of a plurality of sectors  $S_i$  ( $i = 1, 2, \dots$ ), as shown in FIG. 9. Each sector  $S_i$  ( $i = 1, 2, \dots$ ) is formed of the header and the main data part. An encrypted sector key  $EK_{S_i}$  ( $i = 1, 2, \dots$ ) in which the sector key  $K_{S_i}$  is encrypted by the disk key  $K_d$  is stored in the header of each sector  $S_i$ , and encrypted content data in which the user data is encrypted by the sector key  $K_{S_i}$  is stored in the main data part of each sector  $S_i$ . The above  $i = 1, 2, \dots$  indicates the sector number. For simplicity, sector numbers are omitted in a part of figures and descriptions.

The Km generation module 41 comprises a Km memory 41A having stored therein a master key Km which is a secret key which is given when the license of the copyright is received, and comprises a hash function circuit 41B which generates an effective master key Km by a computation process shown in equation (1) described

above from the master key  $K_m$  supplied from the  $K_m$  memory 41A and the authenticated medium identification information DiscID provided from the authentication processing part 26. The hash function circuit 41B supplies the EKd decryption circuit 43 with the master key  $K_m$  and the effective master key  $K_{em}$  created from the authenticated medium identification information DiscID.

This  $K_{em}$  generation module 41 is constructed similarly to the  $K_{em}$  generation module 31 of the encryption part 30, and may also be used as the  $K_{em}$  generation module 31.

The EKd decryption circuit 43 creates the disk key  $K_d$  by decrypting, by the effective master key  $K_{em}$ , the encrypted disk key Ekd read from the lead-in area of the optical disk 1 by the recording/playback head 23, and supplies the decrypted disk key  $K_d$  to the EKs decryption circuit 44.

The EKs decryption circuit 44 creates a sector key  $K_s$  by decrypting, by the disk key  $K_d$ , the encrypted sector key EKs read from the data area of the optical disk 1 by the recording/playback head 23, and supplies the decrypted sector key  $K_s$  to the content data decryption circuit 45.

The content data decryption circuit 45 decrypts, by the sector key  $K_s$ , the encrypted content data read from the data area of the optical disk 1 by the recording/playback head 23.

In the optical disk recording/playback apparatus 20 constructed as described above, when a recording mode is set in the control part 29 as a result of a recording

In the following description, it is assumed that authentication processing has already been performed on the optical disk 1 by the authentication processing part 26 and user data is recorded on the optical disk 1 which is authenticated to be an authorized one.

Next, the Kd encryption/decryption circuit 33 determines whether or not the encrypted disk key Ekd has been recorded in the lead-in area of the optical disk 1 (step S34).

Then, when the encrypted disk key Ekd has not been recorded, the Kd encryption/decryption circuit 33 uses a random number of, for example, 40 bits, generated by the random number generation circuit 32 as a disk key Kd (step S35), creates an encrypted disk key Ekd by encrypting this disk key Kd by the effective

Also, in this optical disk recording/playback apparatus 20, when a playback mode is set in the control part 29 as a result of a recording command being input from the input operation part 28, the control part 29 controls the recording/playback part 27

so that the user data is read from the optical disk 1 in accordance with the procedure such as that shown in the flowchart of FIG. 12.

In the following description, it is assumed that authentication processing has already been performed on the optical disk 1 by the authentication processing part 26 and user data is read from the optical disk 1 which is authenticated to be an authorized one.

In the playback mode, the decryption part 40 of the recording/playback part 27 is in an operating state. The Kem generation module 41 of the decryption part 40 receives authenticated medium identification information DiscID from the authentication processing part 26 (step S51), reads the master key Km from the Km memory 41A (step S52), and causes the hash function circuit 41B to create an effective master key Kem from the medium identification information DiscID and the master key Km (step S53).

Next, the EKd decryption circuit 43 creates the disk key Kd by decrypting, by the effective master key Kem, the encrypted disk key Ekd read from the lead-in area of the optical disk 1 (step S54).

Next, the EKs decryption circuit 44 creates a sector key Ksi by decrypting the encrypted sector key EKsi read from the data area of the optical disk 1 (step S55).

Then, the content data decryption circuit 45 decrypts, by the sector key Ks, the encrypted content data read from the data area of the optical disk 1 (step S56).

Furthermore, the content data decryption circuit 45 determines whether all the

content data to be read has been read (step S57). When there is content data to be read, the next sector is accessed (step S58), and the process returns to step S25, whereby processing from step S55 to step S58 described above is performed repeatedly.

When all the required content data has been completely read from the data area of the optical disk 1 in this manner, the playback mode is terminated.

On the optical disk 1 of which user data recording part 3 records user data by means of the optical disk recording/playback apparatus 20, the data area records the encryption key for the user data, that is, the sector key  $K_s$ , as the encrypted sector key  $EK_s$  encrypted by the disk key  $K_d$ . Furthermore, the lead-in area records the disk key  $K_d$  as an encrypted disk key  $EK_d$  which is encrypted by the effective master key  $K_{em}$  created on the basis of the master key  $K_m$  and the medium identification information  $DiscID$  unique to this optical disk 1. Therefore, playing back the user data is only available on an authorized playback apparatus having the master key  $K_m$  and an authentication processing function for performing authentication processing on the medium identification information  $DiscID$  based on the medium-identification-information verification data created according to the random pattern information recorded in the random-pattern-information recording part 4 of the optical disk 1 and based on the authentication data recorded in the authentication data recording part 5. Decrypting and playing back the user data is impossible on a playback apparatus which does not have the authentication processing function or the





sector key creation part 130 (Kes creation circuit) for creating an effective sector Kes from the sector key Ks generated as a random number in the random number generation circuit 32 on the basis of the effective master key Kem. The content data encryption circuit 35 uses the effective sector key Kes created by the sector key creation circuit 130 to encrypt user data and create encrypted content data.

In this case, as shown in FIG. 14, the decryption part 40 is provided with an effective sector key creation circuit (Kes creation circuit) 140 for creating an effective sector key Kes from the sector key Ks on the basis of the effective master key Kem. The EKs decryption circuit 44 uses the disk key Kd to create a sector key Ks by decrypting the encrypted sector key EKs read by the recording/playback head 23 from the data area of the optical disk 1. From this sector key Ks, the effective sector key creation circuit 140 creates an effective sector key Kes. Using this effective sector key Kes, the content data decryption circuit 45 decrypts the encrypted content data.

Although in the above-described embodiment, the present invention is applied to a recording/playback system using the optical disk 1 constructed as shown in FIG. 1, it is also possible to construct a recording/playback system using a card-shaped recording medium 51 such as that shown in FIG. 15.

More specifically, this card-shaped recording medium 51 shown in FIG. 13 comprises a user data recording part 53 in which user data is recorded, a random-pattern-information recording part 54 in which random pattern information from a random physical phenomenon is recorded, and an authentication data recording

part 55 in which medium identification information created on the basis of the random pattern information detected from the random-pattern-information recording part 54, and the digital signature for each manufacturer with respect to the medium identification information are recorded as authentication data.

Like the above-described optical disk recording/playback system, the recording/playback system using the card-shaped recording medium 51 with such a construction detects random pattern information based on random physical phenomena from the random-pattern-information recording part 54, and creates medium identification information from the random pattern information. Furthermore, authentication data is read from the authentication data recording part 55 on the information recording medium, and authentication processing for the information recording medium can be performed based on the medium identification information created from the random pattern information and the authentication data. An encryption key is created from the medium identification information of the information recording medium authenticated by the authentication processing, and data which is encrypted with the encryption key is recorded/read via the user data recording part 53 on the authenticated information recording medium, making it possible to reliably prevent illegal copying of the information of the user data recording part 53.

As has been described above in detail, the embodiment of the present invention detects random pattern information based on random physical phenomena from the

random-pattern-information recording part on the information recording medium which is provided with a random-pattern-information recording part including recorded therein random pattern information based on random physical phenomena, creates medium identification information from the random pattern information, and records, as authentication data, the medium identification information, together with a digital signature for each manufacturer with respect to the medium identification information, in the authentication data recording part on the information recording medium, making it possible to provide an information recording medium which records, as authentication data, medium identification information, together with a digital signature for each manufacturer with respect to the medium identification information, in the authentication data recording part. Then, with respect to the information recording medium including a random-pattern-information recording part including recorded therein random pattern information from a random physical phenomenon, an authentication data recording part including stored therein medium identification information created based on the random pattern information detected from the random-pattern-information recording part, and a digital signature for each manufacturer with respect to the medium identification information as authentication data, and a user data recording part in which user data is recorded, random pattern information based on random physical phenomena is detected from the random-pattern-information recording part, medium identification information is created from the random pattern information, and authentication data is read from the

authentication data recording part on the information recording medium, and authentication processing for the information recording medium can be performed based on the medium identification information created from the random pattern information and the authentication data. An encryption key is created from the medium identification information on the information recording medium authenticated by the authentication processing, and data which is encrypted with the encryption key is recorded/read via the user data recording part on the authenticated information recording medium, making it possible to construct an illegal-copying prevention system which is also effective for writable media.